Title: Patterns in Nature

Brief Overview:

This 3 day lesson is designed to introduce second grade students to the world of repeating and growing patterns. Students will create, recognize, and extend patterns, as well as make generalizations and apply function rules to understand the logic behind the mathematics. Since patterns are found in the natural world, students will use organic themes such as movement and insects to investigate the concept.

NCTM Content Standard:

- Recognize, describe, and extend patterns such as sequences of sounds and shapes or simple numeric patterns and translate from one representation to another;
- Analyze how both repeating and growing patterns are generated.
- Represent and analyze patterns and functions, using words, tables, and graphs

Grade/Level:

Grade Two

Duration/Length:

Three 60-minute lessons.

Student Outcomes:

- Students will recognize, describe, and extend patterns such as sequences of movements and shapes or simple numeric patterns.
- Students will analyze how both repeating and growing patterns are generated.
- Students will use T-Charts and Function Machines to indentify and predict future pattern terms.

Materials and Resources:

- Day 1 Lesson Resources:
    - Day1 Pre-Assessment *What Comes Next?*
    - Day1 Pre-Assessment *What Comes Next?* Answer Key
    - Day 1 Extension *Caterpillar Families*
    - Day 1 Extension *Caterpillar Families* Answer Key
    - Day 1 Evaluation *Neighborhood Gardens*
    - Day 1 Evaluation *Neighborhood Gardens* Answer Key
    - *Extending Patterns Task Cards*
    - *Extending Patterns Recording Sheet*
    - Stickers (at least 4 different objects or colors)
    - Sentence Strips or strips of card stock
- Day 2 Lesson Resources
    - *Growing Caterpillars* (exploration) *Caterpillar Families* (extension)
    - *Growing Caterpillars* Answer Key
    - *Caterpillar Families* (Extension)
    - *Caterpillar Families* Answer Key

    - *One Grain of Rice Activity* –laminate or place in sheet protectors (Enrichment)
    - *How Does Your Garden Grow?* (evaluation)
    - *How Does Your Garden Grow?* Answer Key
    - Dry-erase markers
    - Calculators
    - Computers (if available)
    - Pattern blocks in bins at each student table
- Day 3 Lesson Resources
    - *T Chart Time* (exploration/explanation)
    - *T Chart Time* Answer Key
    - *Function Machine Template* (Reteach)
    - *Function Machine Mat* (Reteach)
    - *Number Cards* (Reteach)
    - *Function Machine Rule Cards* (Reteach)
    - *Caterpillar Leg Machines* Exit Ticket (Evaluation)
    - Unifix cubes
    - White Boards
    - Dry-erase markers
    - Computers (if available)
- Colored cubes
- Pattern blocks
- Calculators
- Computers
- Pictures of real caterpillars
- White-boards
- Dry-erase markers

Development/Procedures:

Day 1

Objective: Students will be able to describe a pattern and use pattern analysis to supply the next two steps in a repeating pattern.

Pre-assessment (This is for the unit, and will only be found on the first day.)

- Distribute the pre-assessment "*What Comes Next?"* to each student. An answer key is provided.

Engagement

- Have your class form a circle to become a "Circle of Trees."
- Create a repeating AAB pattern using the children in your classroom.
- While you go around the circle, touch each child's right shoulder. Tell the first 2 children to sit, the 3rd to stand and the next 2 children to sit. You may extend the pattern if your students need more hints. Tell students you may ask them what comes next if you see them silently mouthing the words.
- Once each student is sitting or standing, ask the class what they created (A repeating pattern). Ask several students to define a repeating pattern.
- Ask if anyone knows other types of patterns or pattern vocabulary (growing patterns, core).

- List & review pattern terms if needed (core, element).

Exploration

- Problem: Your pet caterpillars have a secret hide-out in your yard. They want to create a secret handshake and they need your help. The caterpillar inside doesn't let them in to the secret hideout until they've shaken the hand of at least 3 outside caterpillars. Create a secret handshake pattern your pet caterpillars can use. With a partner:
    - Perform or show your handshake pattern with symbols.
    - Describe your pattern to your partner.
    - Circulate as groups work.

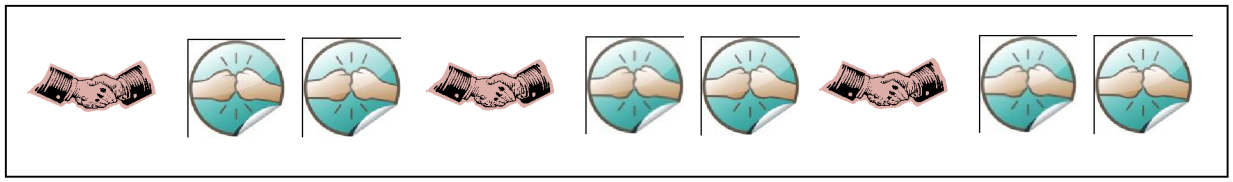
Explanation

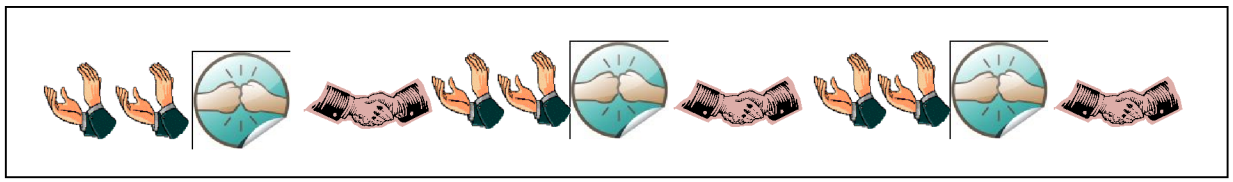
Model: Choose a pattern from one of your exploration groups to use as a model (to differentiate, you can use a struggling group's pattern). The group demonstrates their handshake, then you repeat it, and then the entire class repeats it (Ex: *Handshake, fist bump, fist bump*). Say, "Let's agree that this is the core. The core has 3 elements in it. The core repeats to make a pattern."

Possible Questions to ask to model analyzing a pattern:

- What is the core?
- What would be the 8th action I do?
- How could I describe this to someone? Anyone else? (A, B, B; *Handshake, fist bump, fist bump; H, F,F; or draw it.)*

  Challenge students to help you describe these handshake patterns.





Possible Questions to ask to model analyzing the pattern:

- What is the core?
- What is the 4th action? What would the 15th action be?
- How can I describe this pattern? Anyone else?
- If I added a 3rd clap to the core, how would that change my pattern?

Explain that students now have a chance to create their own caterpillar body (show model), using a repeating pattern. Show some examples of real caterpillars. Remind students that a core is a basic group that repeats 3 or more times to create a repeating pattern. They can choose to make a pattern with 2, 3 or more elements in their core for differentiation. Give each group stickers and a sentence strip for each student. (This can also be used as an informal assessment.) On the back, have the students write a description of their pattern.

While you circulate, ask students the questions below.

- What is the core?
- What is your 5th sticker? What would your 15th sticker be (or a number higher than their last sticker)?
- How many times does the core repeat?
- If your pattern repeated 10 times, how many stickers would you need?
- I see that you have a _____ pattern. What would I have to add / remove to change it to a _____ pattern?

Extension (Students apply/practice the learning.)

- Give a copy of "*Caterpillar Families*" to each student, and explain that they should use letter descriptions (A, B, C etc) to describe the repeating patterns. An answer key is provided.

Differentiation

Reteach

- If students are struggling, make the pattern more concrete by using the student's secret hand shake pattern to help them build it with pattern blocks.
- Ask, "What is the 4th, 8th and 12th block?"
- Direct the students to use pattern blocks to build a pattern with a shorter core or longer core based on the needs of the child.
    - If you have computer access, this website has interactive pattern making activities. http://www.learner.org/teacherslab/math/patterns/index.html

Enrich

- Students complete "*Extending Pattern Task Cards*."

Evaluation (Ongoing formative assessment for Day 1)

- Give students "*Neighborhood Gardens*" exit ticket to complete. An answer key is provided.

Day 2

Objective: The student recognizes, extends, generalizes, and creates a wide variety of patterns and relationships using symbols and objects.

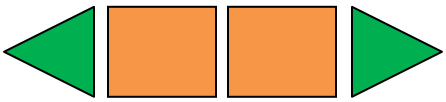
Engagement

- Begin the lesson by gathering the students at the carpet and read aloud, *Pattern Bugs,* by Trudy Harris (2001).
- As you read ask students the following questions:
    - What do we mean by a core pattern?
    - How many times does the pattern repeat?
    - What happens as the pattern repeats? (It grows.)

Explanation

- Take out pattern blocks and build a baby caterpillar.
- Tell students that we are growing baby caterpillars using pattern blocks. On day one your caterpillar has a head (place 1 triangle as the head); a square body (place a square next to the triangle) and another triangle as a tail (place another triangle next to the square).

- Record on chart paper "1 day old" and draw a model of the 1 day old caterpillar.
- Add another square between the two triangles.



- Draw a model of the day two caterpillar underneath the day 1 caterpillar and write "2 day old caterpillar."
- Ask, "What do you notice about the new caterpillar?"
- Ask, "How many shapes do I need to draw a 3 day old caterpillar?"
- Model, draw and label the 3 day old caterpillar on the chart paper.
- Continue asking students about the number of shapes needed to model a 4 and 5 day old caterpillar (no need to draw and label, but you may want to model using pattern blocks).
- Distribute dry-erase boards and ask students to draw the shapes needed to make a 6 day old caterpillar. Students should think quietly, draw their caterpillars and "turn and talk" to share their responses with a neighbor.
- Ask students how they can determine the number of shapes needed to make a 10 day old caterpillar. Students may comment on how long this may take or that they don't have enough room on their dry-erase boards.
- Share with students that this process is cumbersome: with too much writing and drawing and that they need to use a more EFFICIENT WAY.
- Construct a T-chart on the chart paper.

In	Out

- Re-ask the following questions:
  - What if we have a 2 day old caterpillar, how many shapes would we use? (repeat with 3, 4 and 5)
- As the students to respond and add values to the in-and-out function table.
- Tell students this is a T-chart and ask them how it helps them determine the number of shapes the caterpillar will have as it grows older.
- Ask students to help you label columns (Responses should be, "In" means "Number of Days Old" and "Out" means "Number of Shapes.").
- Re-label the T-Chart with "Number of Days Old" and "Number of Shapes."

Exploration

- Explain to students that they will work with a partner to complete the T-Chart for the Growing Caterpillars up to 10 days old. They may model their caterpillars with drawings and write their solutions in the T-chart.
- Distribute Day 2 Resource, Growing Caterpillars Exploration.
- Have students go back to their seats in pairs to work. An answer key is provided.

Extension

- Have students complete Butterfly Family Photographs sheets (Day 2 Extension). An Answer Key is provided.

Differentiation

- Reteach
  - Materials: Day 2 resource page three and T-Chart mat
  - Complete activity in a small focus group using pattern blocks to build growing patterns using a T-Chart mat and dry-erase markers.

- Enrich
  - Students read *One Grain of Rice* in pairs.
  - Complete (Day 2 Resource of Function Table). An answer key is provided.

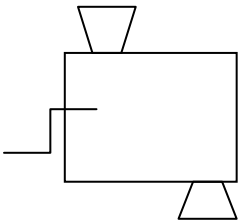
Evaluation

- Have students complete Exit Ticket independently. Answer key is provided.

Day 3 Students will be able to evaluate functions.

Engagement

- Draw or hold up a function machine. Ask what do you think this machine does?



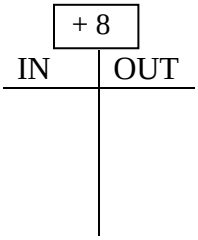
Exploration

- Class discussion:
  - Start with 2 cubes.
  - Put them into the "machine."
  - Say the rule (ex: +3), and as you say the rule, demonstrate the rule using the cubes. For example, if the rule is +3, start with 2 cubes, slide the 2 cubes through the machine and join 3 more to show the students there are now 5 cubes.
  - Change the rule 3 or 4 times and repeat with your machine.

Explanation

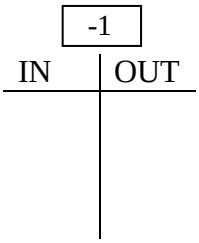
- What does our machine do? (It follows a rule.)
- If we change the IN number, does the rule change? (no)

- So now let's try the same thing without cubes.
- Write the rule + 6 and ask the students what the out number would be if the in number was 2.
- Now I want to organize my numbers in a t chart.
- Draw a T chart as shown below.
- Write the rule on top.
- Put a 2 in the IN column.
- Ask the students what the OUT would be. (10)
- Change the IN number 3 or more times, writing the OUT number.
- Do 3-5 more T charts with different rules. See examples provided on resource sheets.



Extension

- Write the rule -1, and ask the students what the OUT number would be if the in number was 20.
- Draw a T-chart as shown at right.
- Write the rule on top.
- Put a 20 in the IN column.
- Ask the students what the OUT would be. (19)
- Change the IN number 3 or more times, writing the OUT number.
- Do 3-5 more T charts with different rules. See resource sheets that are provided.



Differentiation

- Reteach
  - In small focus group have students practice using function machines using unifix cubes.
  - You will need to cut out Day 3 resource page *Function Rule Cards* and Day 3 resource page *Number Cards.* Place them face down on the table and along with one copy the Day 3 resource page *Function Machine Work Mat* (laminated) http://www.mathwire.com/algebra/functionmachine.pdf .
  - You will need at least 30 unifix cubes.
  - Each student will get a copy of Day 3 resource page *Function Machine Templates* (laminated or in a sheet protector) and a dry-erase marker.
  - Demonstrate turning over a *Number Card* place the number of cubes represented on card on the "In" box. Turn-over a *Function Machine* rule card and place it face-up on the *Function Machine Work Mat.* Say to the students n+3 *is*_____. Take out the correct number of cubes represented on the *Function Machine* rule card put them together with the cube(s) on the "box" and slide them over to the "Out" box.
  - Model recording the "In" value, the "rule" and the "out value on the *Function Machine Templates.*
  - Students will take turns drawing *Number Cards* and *Function Machine Card* and filling out the *Function Machine Templates.*

- Enrich
  - Assign students to independently play on the computer *Stop that Creature* (http://pbskids.org/cyberchase/games/functions/)

Evaluation

- Distribute Exit Ticket Day 3 Resource *Caterpillar Leg Machines!* for students to complete. An answer key is provided.
- Students should complete the Exit Ticket.

Summative Assessment:

Distribute the student resource *Summative Assessment*. Students will identify patterns, complete T-Charts and solve Function Machines. The students will answer a BCR using what they know; symbols, words, pictures or charts in order to figure out number of legs a baby caterpillar grows after 21 days. The teacher resource, *Summative Assessment Answer Key,* is available for evaluating the summative assessment.

Authors:

Allison Lewis-Fleming
Friends Community School

Megan Smith
Charles E. Smith Jewish Day School

What Comes Next? (Day 1 Pre-assessment)

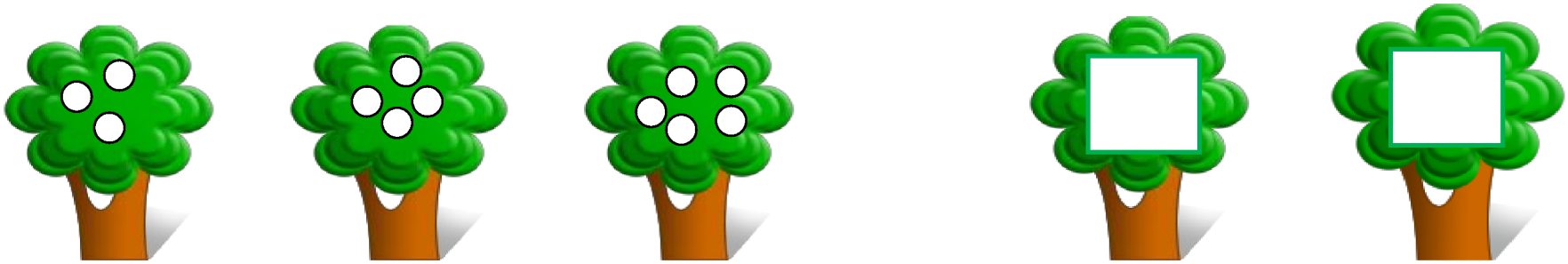
Name: _____

1. Describe the pattern using words, symbols or letters.

_____

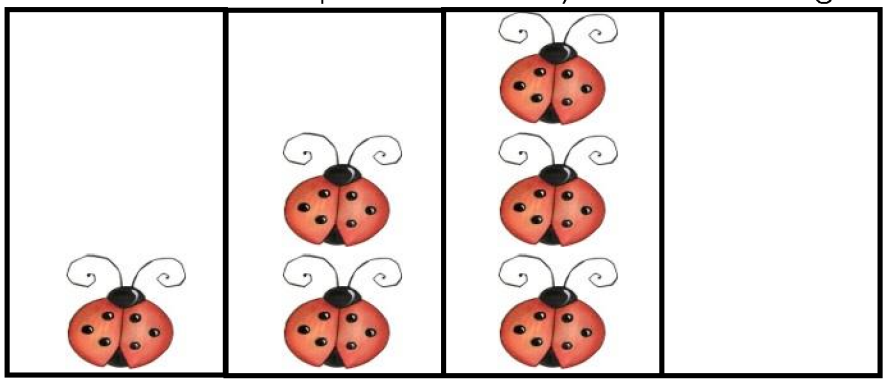
2. If you know what the **core** of the pattern in #1 is, circle it.

3. Complete the pattern by adding apples to the last 2 trees.



How many dots?

4. Describe the pattern of dots you see in each group of ladybugs using words, numbers or a chart.



group 1 group 2 group 3 group 4

Circle how many total dots the ladybugs in group 4 would have. 12 18 24 30

What Comes Next? (Day 1 Pre-assessment)

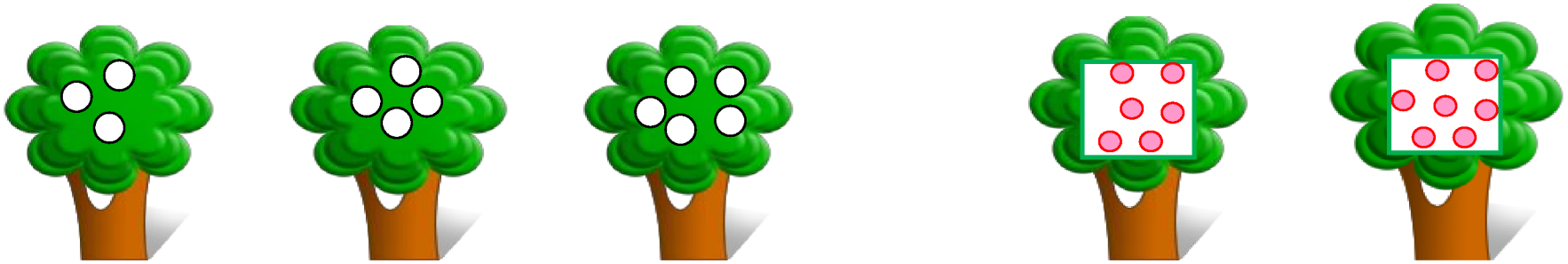
Name: _____

1. Describe the pattern using words, symbols or letters.

Moon, moon, star; M, M, S; A, A, B; etc.

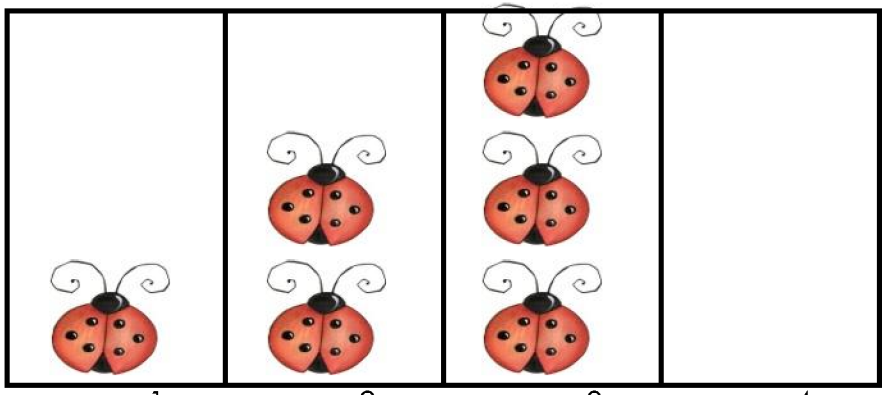
2. If you know what the **core** of the pattern above is, circle it.

3. Complete the pattern by adding apples to the last 2 trees.



How many dots?

4. Describe the pattern of dots in each group of ladybugs you see using words, numbers or a chart.



group 1	group 2	group 3
6 dots	12 dots	18 dots

5. Circle how many total dots the ladybugs in group 4 would have. 12 18 24 30

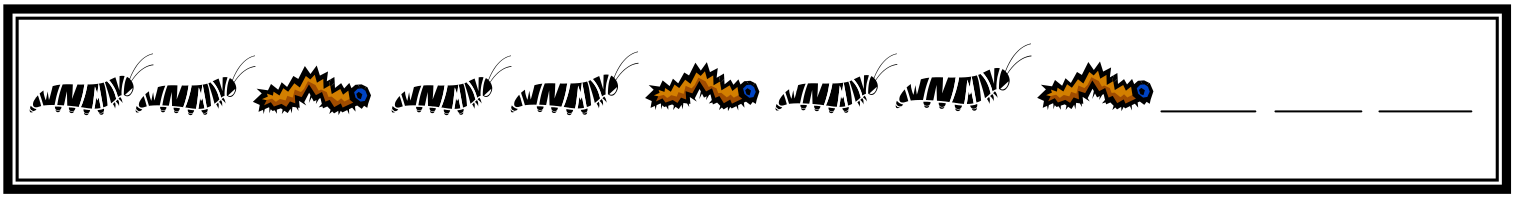
Caterpillar Families (Day 1extension)

Below are several different caterpillar families. Answer the questions after the picture of each family.

A. Describe the next 3 caterpillars in the pattern above.
B. Use letters to describe the pattern's core.

_____ _____ _____ _____ _____ _____

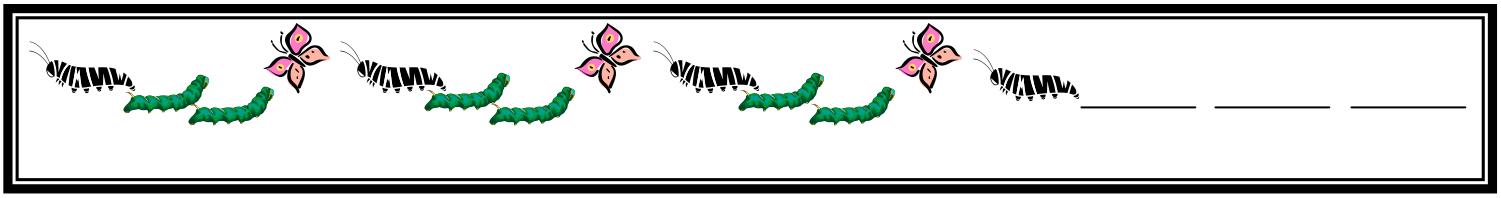
C. What would the 10th caterpillar be? _____



A. Describe the next 3 caterpillars in the pattern above.
B. Use letters to describe the pattern's core.

_____ _____ _____ _____ _____ _____

C. What would the 13th caterpillar be? _____



A. Describe the next 3 pictures in the pattern above.
B. Use letters to describe the pattern's core.

_____ _____ _____ _____ _____ _____

C. What would the 19th picture be? _____

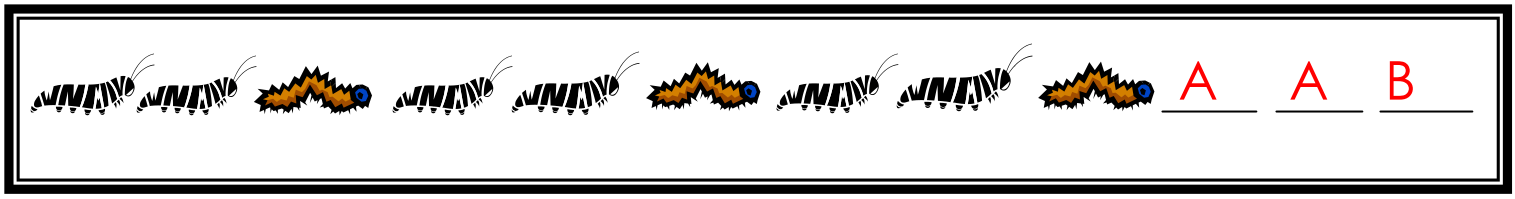
Caterpillar Families (Day 1extension)

Below are several different caterpillar families. Answer the questions after the picture of each family.

A. Describe the next 3 caterpillars in the pattern above.
B. Use letters to describe the pattern's core.

A B

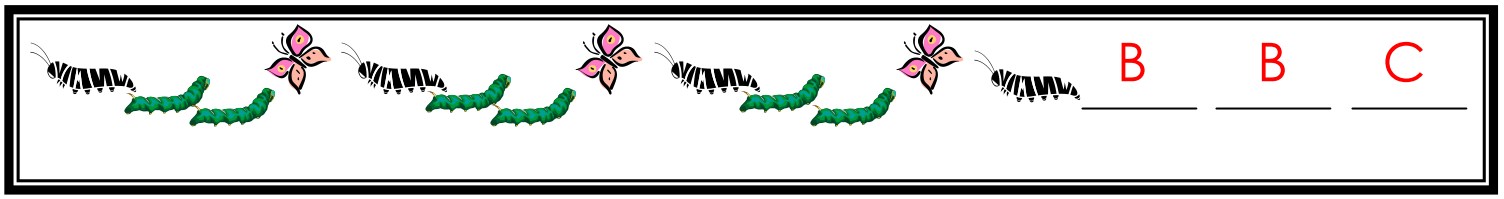
C. What would the 10th caterpillar be? B



A. Describe the next 3 caterpillars in the pattern above.
B. Use letters to describe the pattern's core.

A A B

C. What would the 13th caterpillar be? A



A. Describe the next 3 pictures in the pattern above.
B. Use letters to describe the pattern's core.

A B B C

C. What would the 19th picture be? B

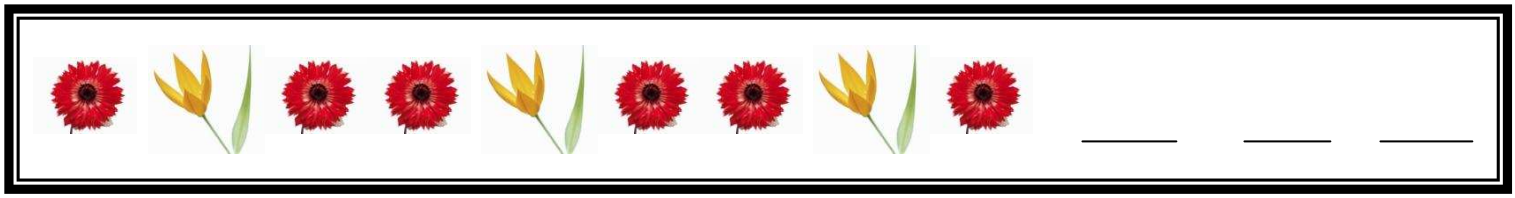
Neighborhood Gardens (Day 1 Evaluation) Name: _____

Below are several different neighborhood gardens. Answer the questions after the picture of each garden.

A. Complete the blanks in the garden pattern above.
B. Describe the pattern's core.

_____ _____ _____ _____ _____ _____

C. What would the 17th flower be? _____



A. Complete the blanks in the garden pattern above.
B. Describe the pattern's core.

_____ _____ _____ _____ _____ _____

C. What would the 13th flower be? _____

A. Complete the blanks in the garden pattern above.
B.Describe the pattern's core.

_____ _____ _____ _____ _____ _____

C. What would the 17th flower be? _____

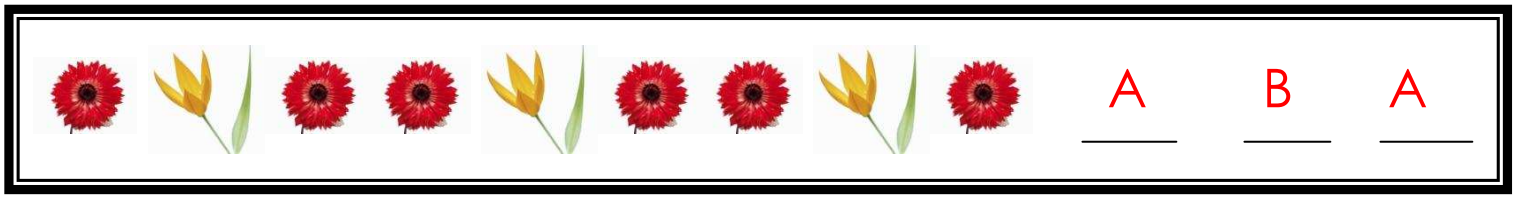
Neighborhood Gardens (Day 1 Evaluation Answer Key) Name: _____

Below are several different neighborhood gardens. Answer the questions after the picture of each garden.

A. Complete the blanks in the garden pattern above.
B. Describe the pattern's core using letters.

A B C C _____ _____

What would the 17th flower be? A



A. Complete the blanks in the garden pattern above.
B. Describe the pattern's core using letters.

A B A _____ _____ _____

C. What would the 11th flower be? B

A. Complete the blanks in the garden pattern above.
B. Describe the pattern's core.

A B C B _____ _____

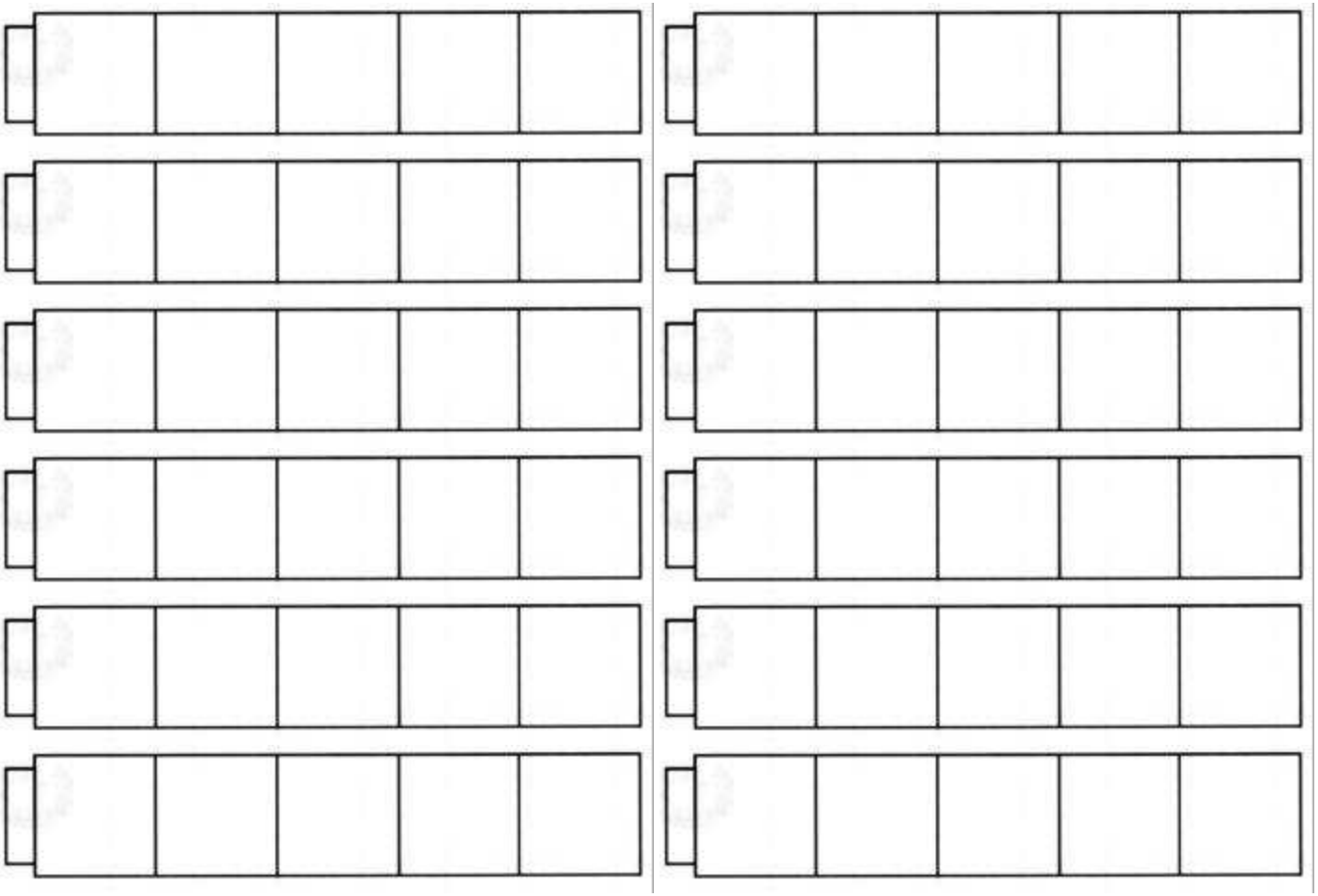
C. What would the 11th term be? C

Extending Patterns Task Cards (Day 1 Enrich)

Task 1 1. Color a pattern with a 5 element core. 2. Star the 17th block. 3. How many cores did you use? 4. Were there any left over? If so, how many?	Task 2 1. Color a pattern with a 3 element core. 2. Star the 25th block. 3. How many cores did you use? 4. Were there any left over? If so, how many?	Task 3 1. Color a pattern with a 4 element core. 2. Star the 32nd block. 3. How many cores did you use? 4. Were there any left over? If so, how many?
Task 4 1. Color a pattern with a 2 element core. 2. Star the 63th block. 3. How many cores did you use? 4. Were there any left over? If so, how many?	Task 5 1. Color a pattern with a 4 element core. 2. Star the 43th block. 3. How many cores did you use? 4. Were there any left over? If so, how many?	Task 6 1. Color a pattern with a 5 element core. 2. Star the 54th block. 3. How many cores did you use? 4. Were there any left over? If so, how many?

Name: _____

Extending Patterns Recording Sheet (Day 1 Enrich)



Number of cores used _____ Leftovers: _____

Name: _____

Growing Caterpillars (Day 2 Exploration)

Draw your caterpillars from 1 to 10 days old and complete the chart.

Days Old	Number of Shapes
1	
2	
3	
4	
5	
6	
7	
8	
9	

Name: _____

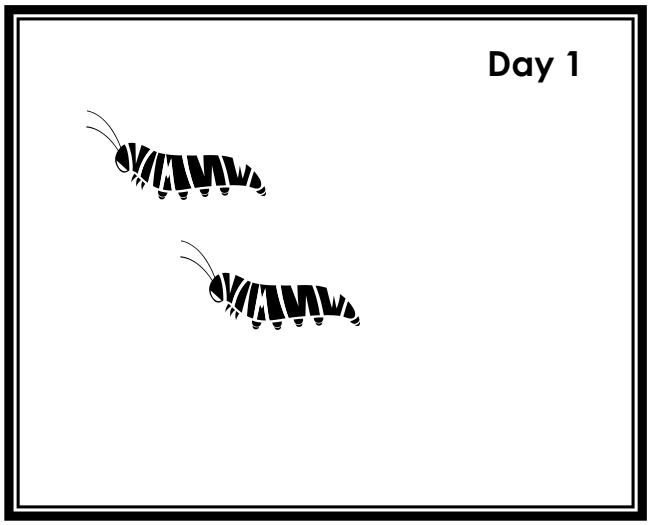
Growing Caterpillars (Day 2 Exploration) Answer Key

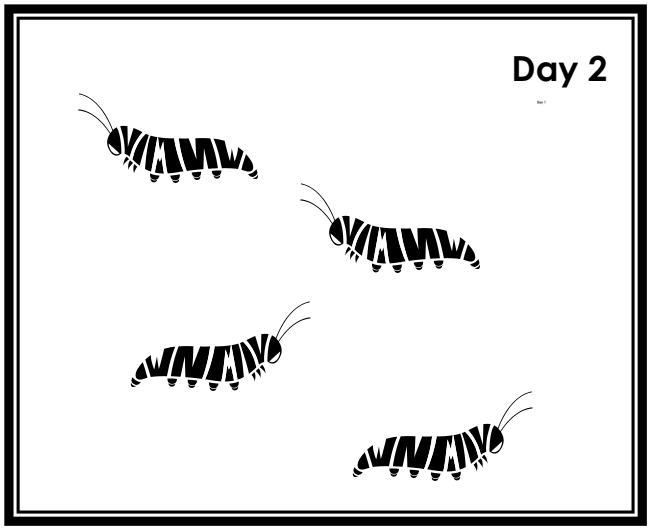
Draw your caterpillars from 1 to 10 days old and complete the chart.

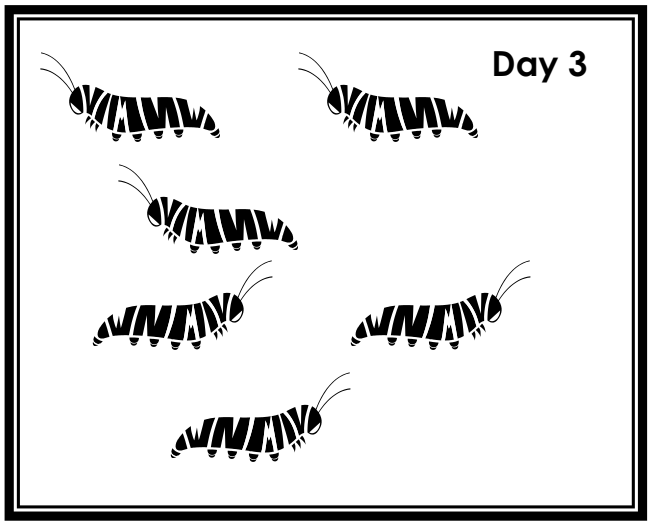
Days Old	Number of Shapes
1	3
2	4
3	6
4	8
5	10
6	12
7	14
8	16
9	18
10	20

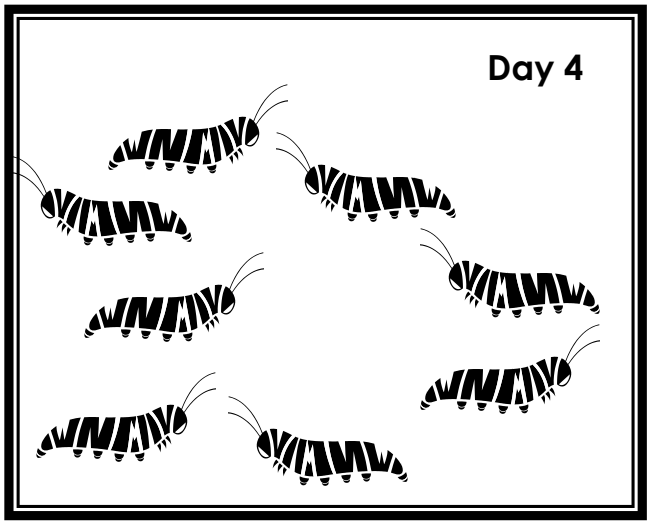
Butterfly Family Photographs (Day 2 Extension)

The butterfly has laid more than 200 eggs on a milkweed plant. Let's start with Day One. Answer the questions using the pictures below.









How many caterpillars hatched on day 3? _____

How many caterpillars will hatch on day 7? _____

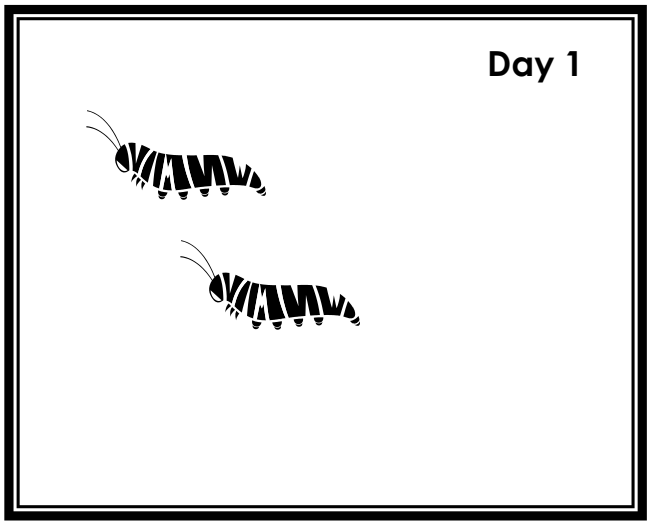
Use what know to describe the pattern on the lines below.

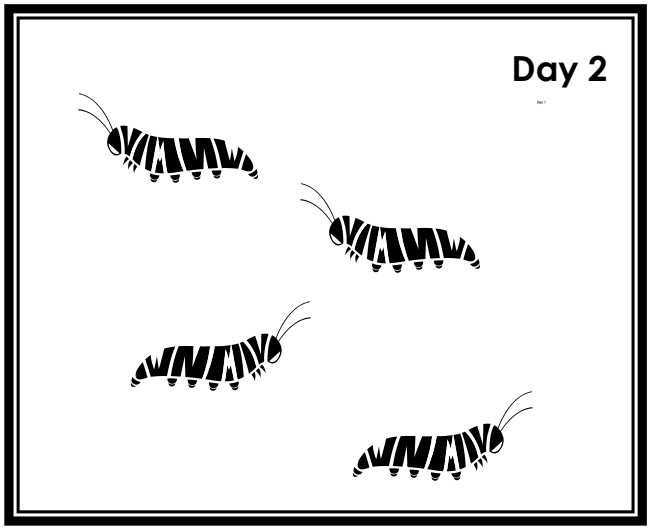
_____

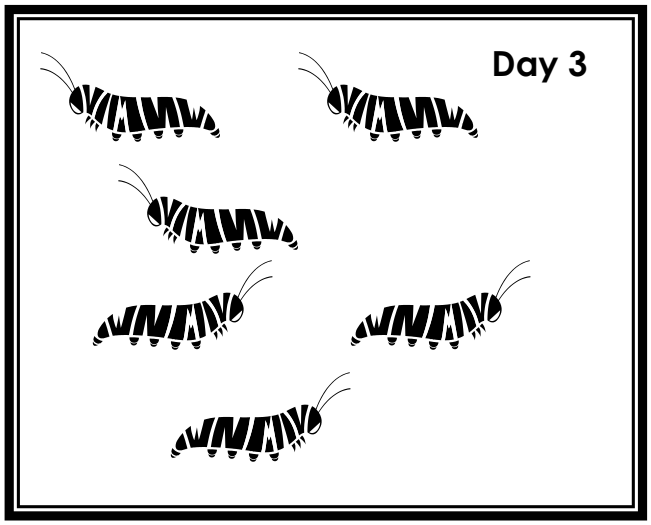
_____

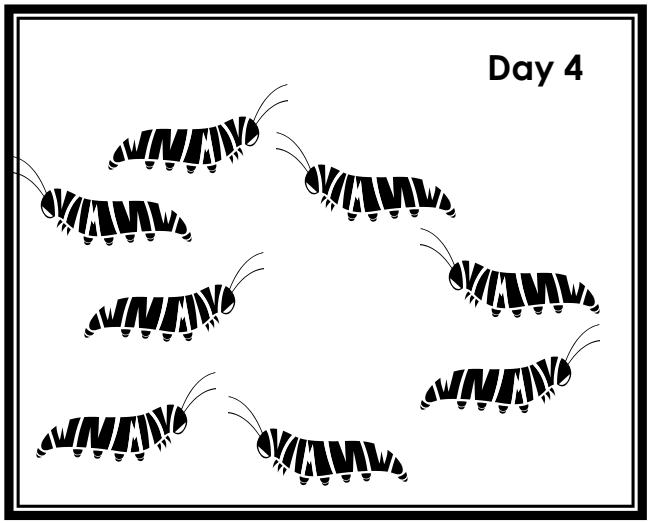
Butterfly Family Photographs (Day 2 Extension) Answer Key

The butterfly has laid more than 200 eggs on a milkweed plant. Let's start with Day One. Answer the questions using the pictures below.









How many caterpillars hatched on day 3? ____6____

How many caterpillars will hatch on day 7? ___14___

Use what you know to describe the pattern on the lines below.

Responses vary

Butterfly Family Pattern Analysis (Day 2 Extension p 2)

1. How many eggs hatch on each day? Use your butterfly family pictures to help you.

Day	Caterpillars
1	
2	
3	
4	
5	

2. Be a naturalist! Figure out the rule for how many of the caterpillar's eggs hatch each day.

_____

How did you figure out the rule?

_____

_____

_____

_____

3. How many caterpillars are in the family on Day 13? _____

Day 56? _____

One Grain of Rice Activity (Day 2 Enrich)

For 3 players

Materials

- The book *One Grain of Rice* by Demi
- *One Grain of Rice* T-Chart Sheet
- Calculator
- Dry-erase markers
- Scratch paper

Directions

- 1 person reads part of *One Grain of Rice* by Demi up to the 14th day.
- 1 person calculates the amounts of rice.
- 1 person records the calculator totals on the One Grain of Rice T- Chart sheet.
- Look at the information on the chart. Your team needs to determine the growing pattern for the increase of each day and write a rule.
- Use the rule to determine how many grains of rice the girl will have in 15 days.

Names: _____

One Grain of Rice Activity

#Days	Grains of Rice
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

#Days	Grains of Rice
11	
12	
13	
14	
15	

Use your T-Chart to come up with a rule that will help your group figure out how many grains of rice will she have in one 15 days?

_____

Answer Key

One Grain of Rice Activity

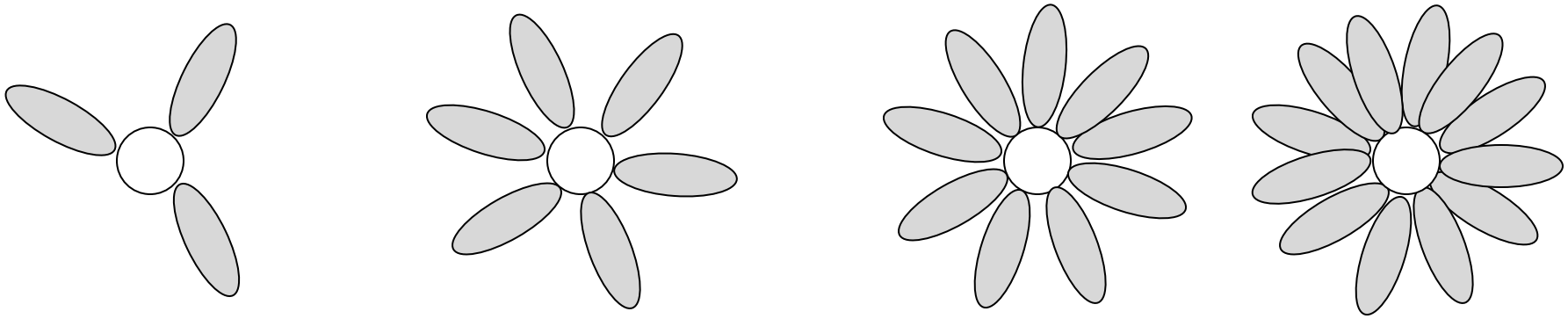
#Days	Grains of Rice
1	1
2	2
3	4
4	8
5	16
6	32
7	64
8	128
9	256
10	512

#Days	Grains of Rice
11	1, 024
12	2, 048
13	4, 096
14	8, 192
15	16, 384

Use your T-Chart to find a rule that will help your group determine how many grains of rice will she have in 15 days? The "out" number becomes the next days "in" number. Then you double the "in" number each time to get the "out" number.

How Does Your Garden Grow? (Day 2 Exit ticket)

Your prized flower begins with 3 petals.



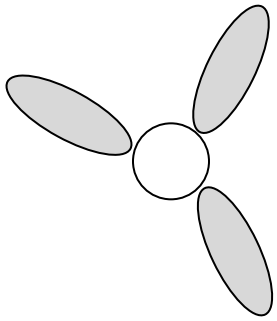
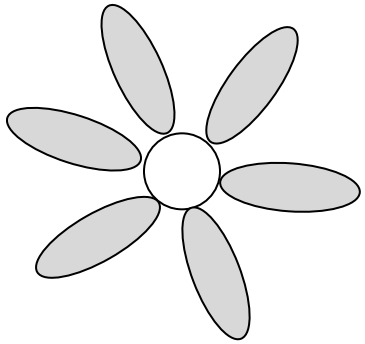
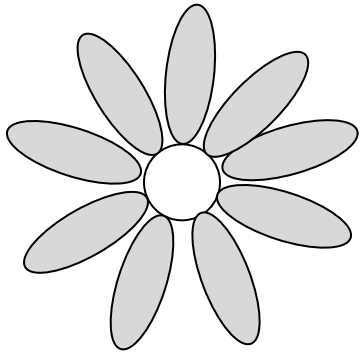
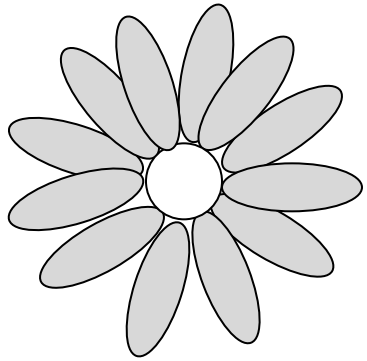
1. How many petals does your flower have at the end of 4 days? _____
2. How many petals does your flower have at the end of 6 days? _____
3. When would your flower have 24 petals? _____
4. Describe your pattern:

_____

_____

How Does Your Garden Grow? (Day 2 Exit ticket Answer Key)

Your prized flower begins with 3 petals.

1. How many petals does your flower have at the end of 4 days? _____ 12
2. How many petals does your flower have at the end of 6 days? _____18

3. When would your flower have 24 petals? _____at the end of 8 days_____

4. Describe your pattern:

_____The flower starts with 3 petals and adds 3 each day. _____

_____

T chart Time (Day3 Explanation)

Name: _____

+ 8

IN	OUT
9	
7	
0	
13	
5	

+ 3

IN	OUT
4	
7	
11	
19	
27	

+ 5

IN	OUT
6	
3	
12	
18	
22	

+ 6

IN	OUT
7	
0	
15	
23	
30	

T chart Time (Day3 Extension)

Name: _____

-2

IN	OUT
25	
14	
2	
15	
7	

-5

IN	OUT
55	
30	
11	
19	
27	

-3

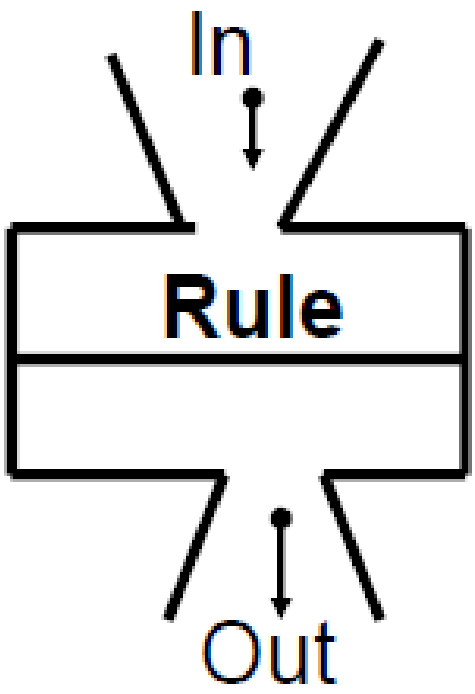
IN	OUT
6	
3	
12	
18	
22	

- 6

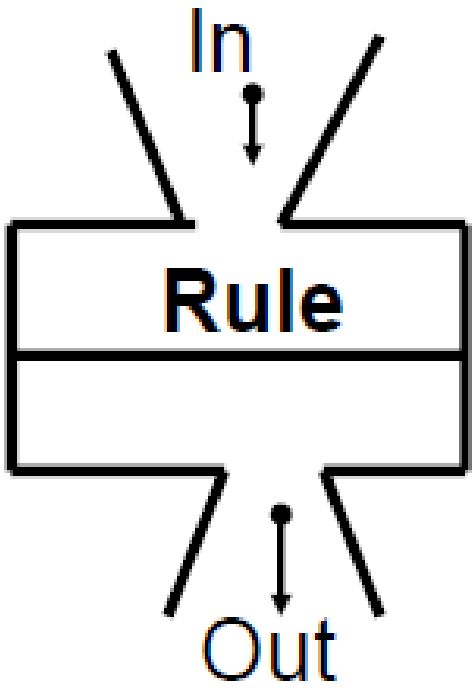
IN	OUT
11	
8	
15	
23	
30	

Function Machine Template (Day 3 Reteach)

Name: _____



In	Out



In	Out

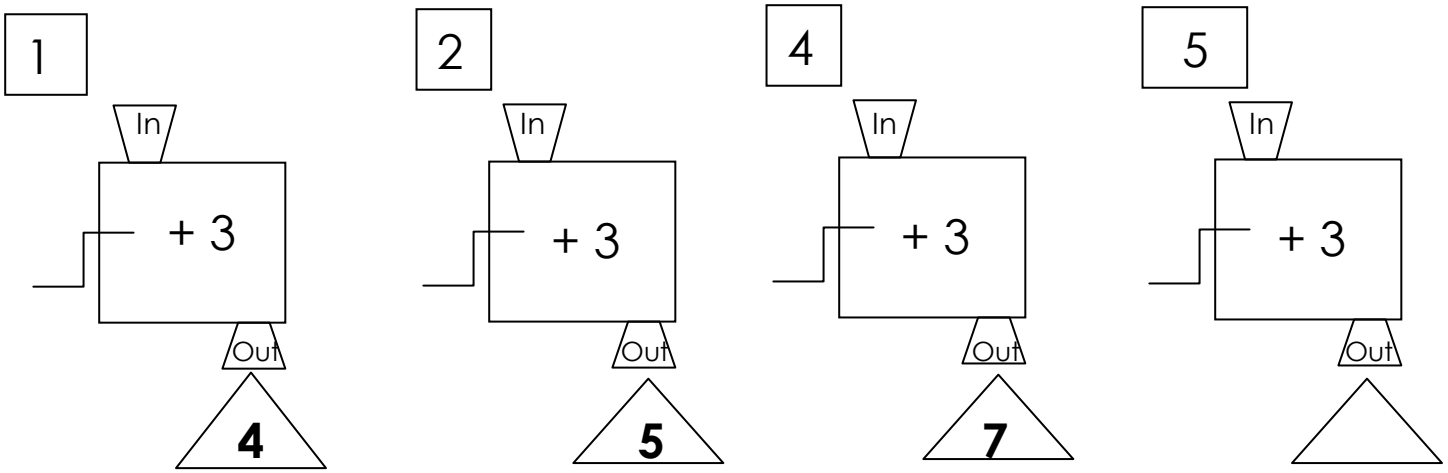
Caterpillar Leg Machines (Day 3 Evaulation)

Name: _____

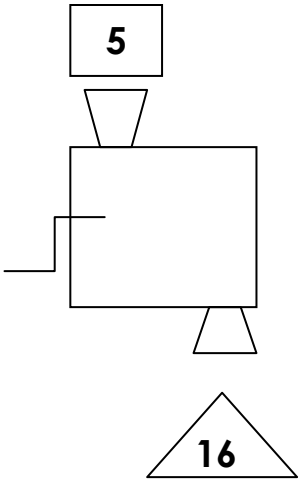
You put your caterpillar's body into the function machine in order to give it legs so it can walk. The first two machines show you what happens.

Complete the missing part of each function machine below.

1.



2.



Use words, numbers or symbols to explain your answer below.

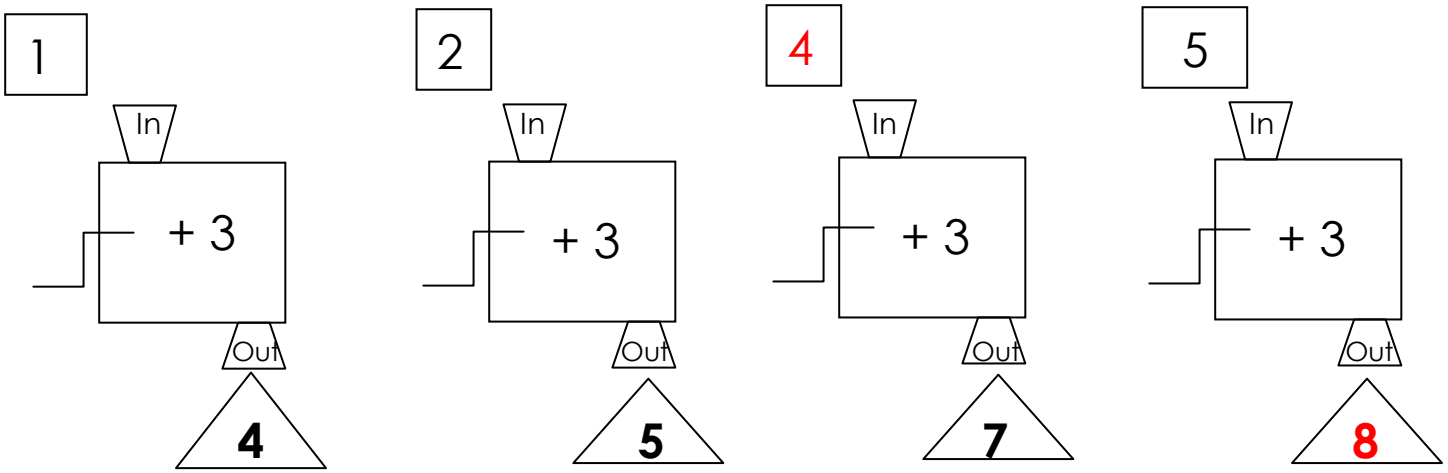
Caterpillar Leg Machines (Day 3 Evaulation) **Answer Key**

Name: _____

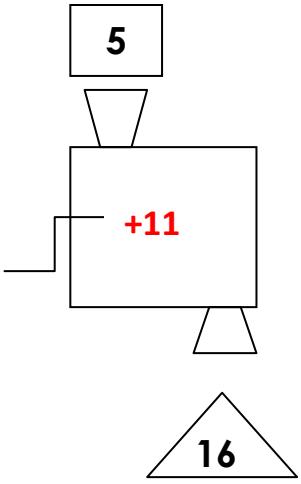
You put your caterpillar's body into the function machine in order to give it legs so it can walk. The first two machines show you what happens.

Complete the missing part of each function machine below.

2.



2.

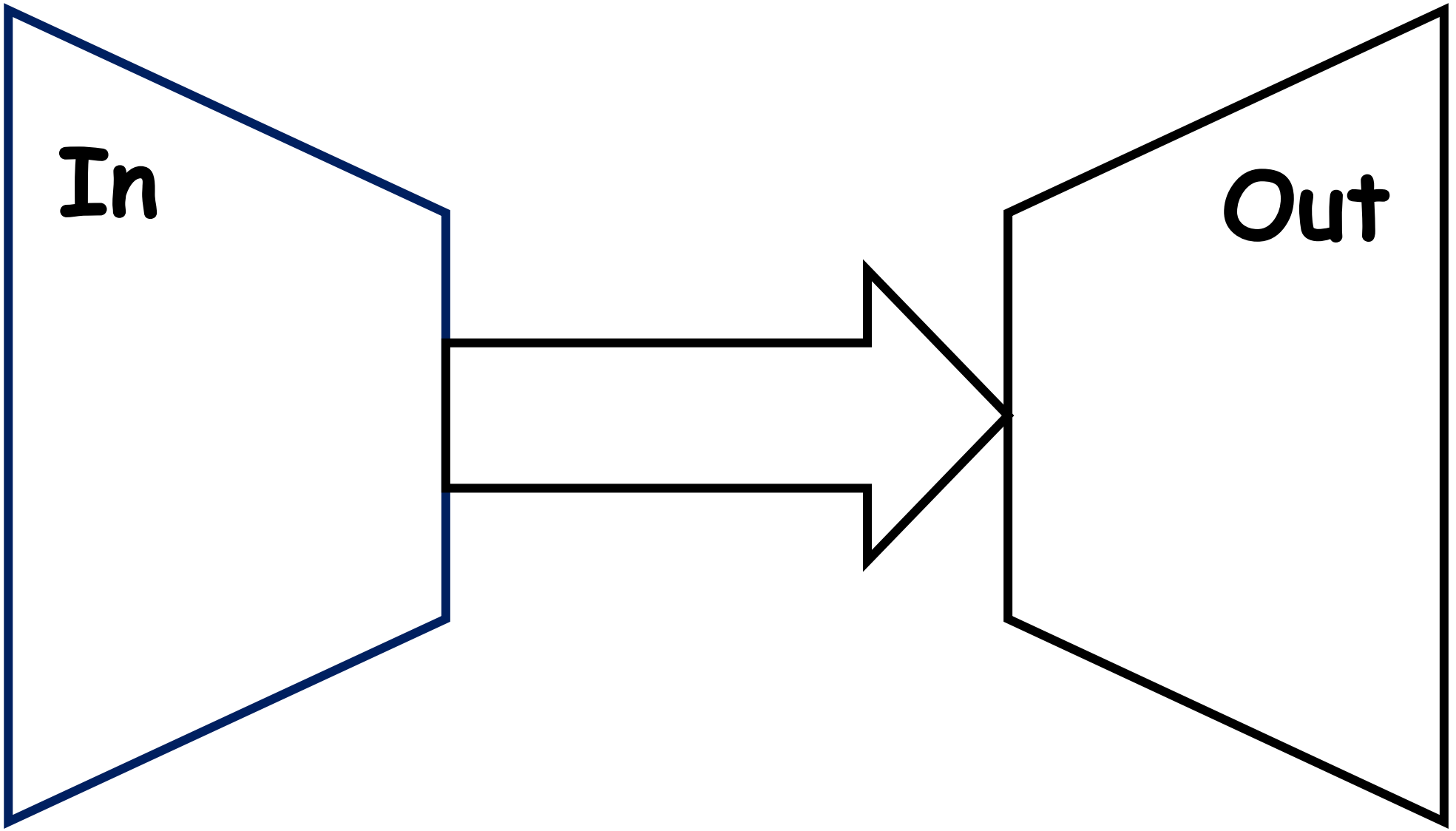


Use words, numbers or symbols to explain your answer below.

Function Machine Mat

Number Cards

Rule Cards



Function Rule Cards

+0	+1	+2	+3	+4
+5	+6	+7	+8	+9
+10	+11	+12		

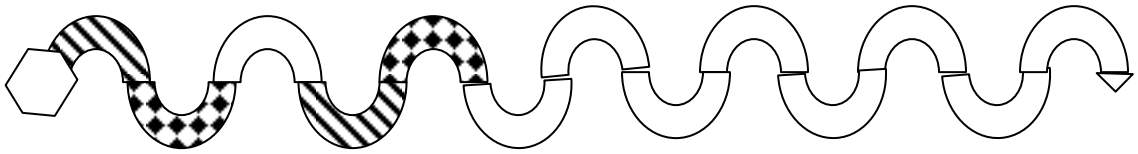
Number Cards

0	1	2	3	4
5	6	7	8	9
10	11	12		

Summative Assessment

Name: _____

1. Continue the snake's pattern 2 more times.



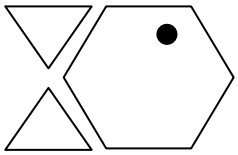
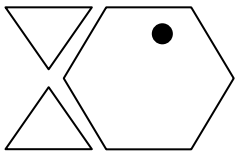
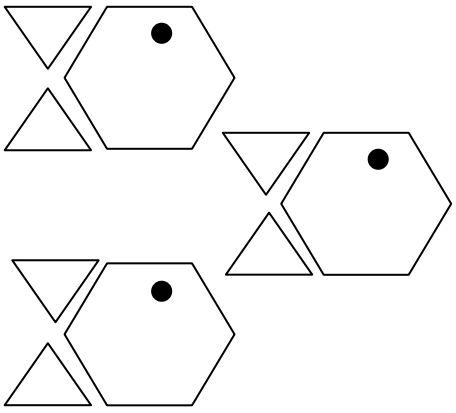
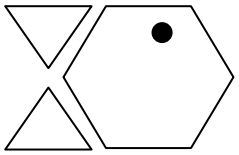
Use your words to describe the snake's pattern.

_____

_____

2. Fill in the chart.

Fish and Fins

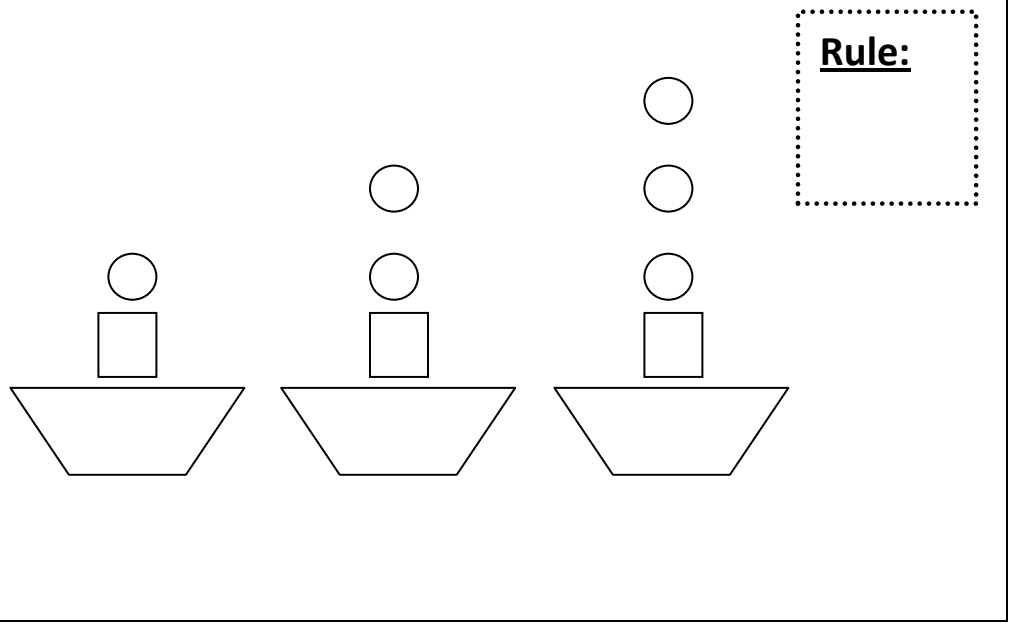
Number of Fish	Number of Fins	One Fish	Two Fish	Three Fish
1	2			
2				
3				
4				
5				

3. What's my rule?

The steamships smoke stake puffs each time the horn is blown. Fill in the chart.

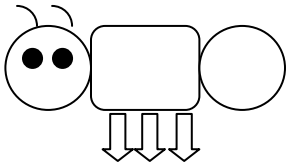
Steamships' Horn Blows

Horn Blows	Puffs of Smoke
1	1
3	
4	

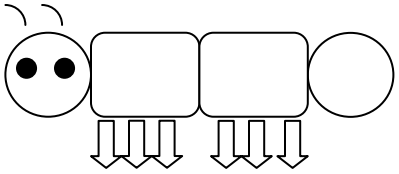


How Many Legs?

Our class caterpillar eggs have hatched. All caterpillars have a head, a body and a tail. A caterpillar that is 1 day old looks like this



Each day, the caterpillar grows 1 more bodies and three more legs. This is what it looks like after two days



4. Draw a picture of the baby caterpillar after 4 days.

5. One caterpillar has 21 legs. How many days old do you think it is? _____

6. Explain or show how you figured it out.

_____

_____

_____

7. Complete the function machines.